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BIOLOGICAL BULLETIN

THE ODD CHROMOSOME IN CERASTIPSOCUS VENOSUS.[1]

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Many groups of insects belonging to the species *Cerastipsocus venosus* were found on one ash tree near the laboratory at Woods Hole last summer. As they belong to the Corrodentia, an order of insects in which the chromosome history has not yet been worked out, it seemed worth while to study the spermatogenesis. They are gregarious in habit and not strong flyers. In the middle of August there were still many nymphs, but they all soon developed wings and by September 1 had all flown from the ash tree. The material used was partly from nymphs and partly from adults. The males are slightly smaller than the females, and both nymphs and adults furnished the entire series of stages for the study of the spermatogenesis. The spermatogenesis falls into line with that of many insects in other orders. There is an odd chromosome that does not divide in the first spermatocyte division.

Methods.

The testes are small trilobed organs, resembling clover leaves, situated dorsally, one each side of the anterior end of the abdomen. The most of this study was made from acetocarmine preparations, but compared with material fixed in Gilson or Flemming and stained in iron hæmatoxylin or thionin. The small testis was put whole in a drop of Schneider's acetocarmine on a slide, left there a couple of minutes, covered with a cover-glass, pressed flat, all extra acetocarmine was drawn off with

[1] I wish to express my thanks to Dr. Pearl for criticizing the manuscript of this and the following paper, to the Director of the Marine Biological Laboratory for the facilities offered me at Woods Hole, and to Mr. Nathan Banks and Mr. E. P. Van Duzee for identifying the species.

filter paper until the edges of the coverglass were dry, and then the edges were covered with vaseline to prevent evaporation. The value of such preparations has already been pointed out many times by N. M. Stevens. They can be used immediately and will often last a couple of weeks. All chromatic structures are distinctly fixed and stained, and some achromatic structures also. The size of the cells is much larger than in preserved material, due partly, as shown by Dr. Stevens,[1] to actual swelling in the acetic acid, and partly to the avoiding of the shrinkage in alcohol and xylol (Figs. 3 and 4). This method insures the study of whole cells and avoids any danger of missing parts of a cell cut off in other sections. If the material is properly pressed out under the coverglass, there will be only a single layer of cells. All the drawings but one in this paper were made from such preparations.

Observations.

In each lobe of the testis, the stages of spermatogenesis are arranged in a series from the distal end to the end joining the duct. The spermatogonial number is 17 (Fig. 1). Spermatogonial plates were not frequent but this number was counted clearly in four plates. The size of chromosomes varies somewhat but not sufficiently to study chromosome individuality. Not even the odd chromosome can be identified in the spermatogonia.

The odd chromosome differentiates itself first in the growth stages of the primary spermatocytes. In the early spermatocytes there is a long piece of the spireme lying close against the nuclear wall, that stains darker than the rest (Fig. 2). This next becomes more condensed and shorter, appearing as several beads. Some of the different forms are shown in Fig. 5. Finally it becomes a solid round intensely staining body in the midst of a nucleus with a very lightly staining spireme (Fig. 3). It sometimes retains, however, a slightly elongated shape in prophase (Fig. 6) and even on the spindle of the first spermatocyte division (Fig. 8). A plasmosome is also present during these growth stages.

In the stages of the first spermatocyte division, the odd chromosome is easily distinguishable from the others by its single condi-

[1] Stevens, N. M., 1908, "A Study of the Germ Cells in Certain Diptera," *Jour. Exp. Zoöl.*, V., p. 359.

tion. In prophase there are 8 bivalent chromosomes, appearing as dumbbells or tetrads while one odd chromosome remains round or slightly oblong with no signs of approaching division (Figs. 6 and 7). In metaphase as the dumbbells and tetrads become grouped at the equator of the spindle, the odd chromosome often still lags to one side of the equator (Figs. 8 and 9). In all these prophase and metaphase groups, the chromosomes are so large and distinct that there is no difficulty in being sure of the full number, 8 dumbbells or tetrads and one odd chromosome with no sign of division. The dumbbells are probably side views of the tetrads, as Fig. 8 shows nearly all tetrads. In the equatorial plates, the odd chromosome appears off to one side (Fig. 10). In anaphase, it sometimes precedes (Fig. 11), and sometimes follows (Fig. 12) the other chromosomes to one pole of the spindle. Fig. 13 shows the telophase of this division: the odd chromosome stands at one end of the spindle in one secondary spermatocyte, with no mate in the corresponding secondary spermatocyte. In Fig. 14, the chromosomes can be counted in the two reconstructing nuclei of the two cell products of one primary spermatocyte division: 8 dumbbells on one side, 8 dumbbells and one single odd chromosome on the other. Each dumbbell in the secondary spermatocyte represents half of a tetrad. Thus the plane of the second spermatocyte division was indicated already in the prophase of the first spermatocyte division, and still is in the prophase of the second, but there is no way to tell which is the reducing division. Among these telophase stages in one individual were a few abnormally large cells in which the mitotic mechanism had somewhere failed, and there was an unreduced number of chromosomes (Fig. 15). Here there are 16 dumbbells and the odd chromosome is recognizable from its round shape and its position to one side of the group. By the time the odd chromosome gets into the equatorial plate for the second spermatocyte division it is also a dumbbell in shape and cannot be distinguished from the others. Nothing but dumbbells appear on the secondary spermatocyte spindle, so the odd chromosome must divide in this division (Fig. 16). The equatorial plates of the secondary spermatocytes show the expected difference in the number of chromosomes, some 8

(Fig. 17), and some 9 (Fig. 18), but the odd chromosome is indistinguishable by either size or position. The anaphases show no chromosome lagging behind or behaving in any way differently from the others.

The behavior of the odd chromosome necessitates the conclusion that *Cerastipsocus venosus* has dimorphic spermatozoa. If half of the secondary spermatocytes have one more chromosome than the others, the spermatids and spermatozoa developing from them must also have one more chromosome. The chief interest in this study lies in the fact that it shows the existence of an odd chromosome in a species of the Corrodentia, an order in which it has not before been described, and therefore adds another order of insects to the list of those with sex chromosomes.

Summary.

1. The spermatogonial number of chromosomes is 17.

2. The odd chromosome is condensed in the growth stage, first as a long beadlike structure, later as one round body.

3. There are 9 chromosomes in the primary spermatocytes, 8 bivalent and one undivided odd chromosome.

4. The odd chromosome does not divide in the first spermatocyte division.

5. There are 9 chromosomes in half of the secondary spermatocytes and 8 in the other half.

6. All the chromosomes, including the odd chromosome, divide in the second spermatocyte division.

7. Therefore, this species of Corrodentia has dimorphic spermatozoa.

University of Maine, Orono,
November, 1912.

All figures were drawn with a camera lucida, 1/12 oil immersion and a 12 compensating ocular, no reduction. All drawings but Fig. 4 are from acetocarmine preparations.

EXPLANATION OF PLATE I.

FIG. 1. Metaphase of spermatogonium, showing 17 chromosomes.

FIGS. 2, 3. Spermatocyte growth stages, showing plasmosome (*P*) and two stages of condensation in the odd chromosome (*X*).

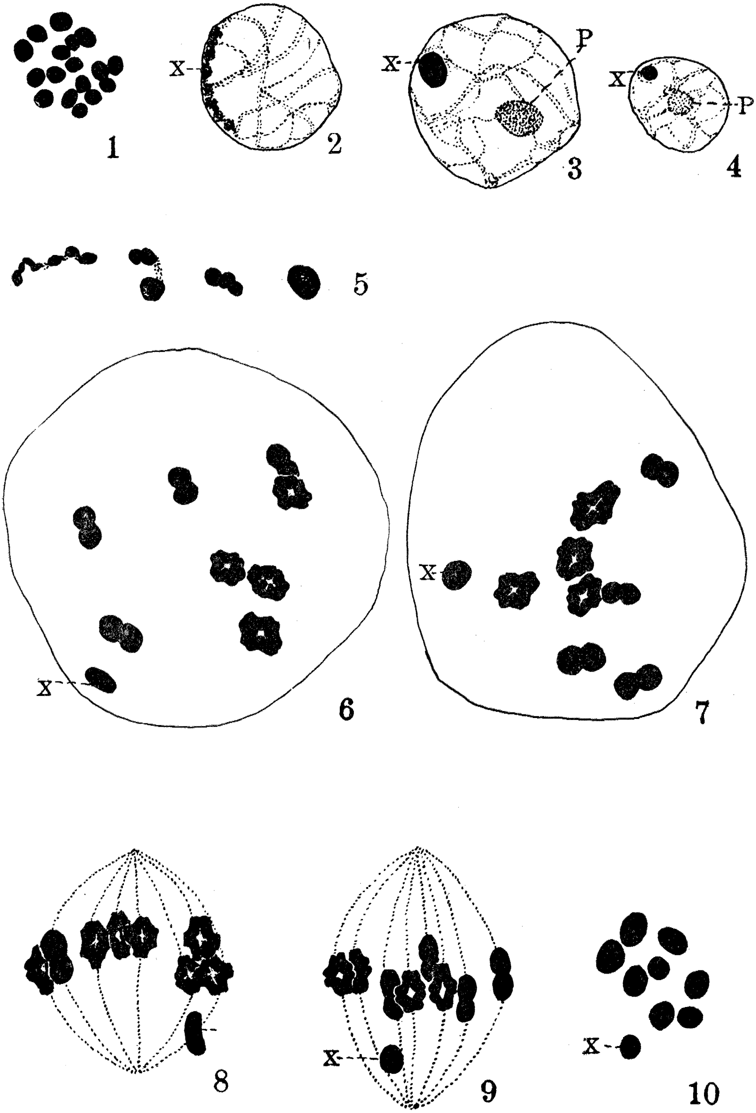
FIG. 4. Same stage as 3, but from permanent preparation fixed in Gilson.

FIG. 5. Odd chromosome in different stages of growth.

FIGS. 6, 7. Prophases of primary spermatocytes, 8 bivalents and 1 single odd chromosome (*X*).

FIGS. 8, 9. Metaphase spindles of primary spermatocytes, odd chromosome (*X*) toward one pole.

FIG. 10. Equatorial plate of primary spermatocyte, 9 chromosomes, odd chromosome (*X*) to one side of the group.



A. M. BORING.

Explanation of Plate II.

Figs. 11, 12. Anaphases of primary spermatocyte division, odd chromosome (X) undivided at one pole.

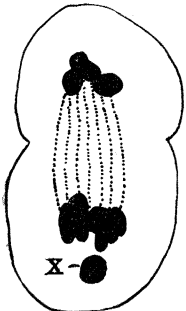
Figs. 13, 14. Two pairs of secondary spermatocytes, X present in only one of each pair.

Fig. 15. Abnormal secondary spermatocyte, 16 chromosomes and 1 odd chromosome (X).

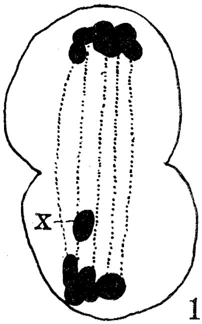
Fig. 16. Metaphase of secondary spermatocyte, all chromosomes dividing.

Figs. 17, 18. Equatorial plates of secondary spermatocytes, one with 8, the other with 9 chromosomes.

Fig. 19. Anaphase of secondary spermatocyte, no lagging chromosome.



11



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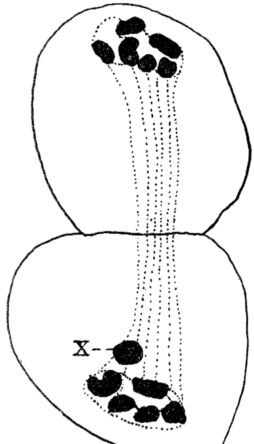

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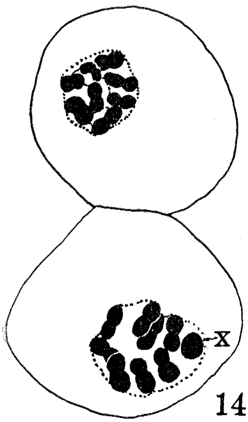

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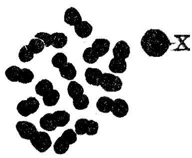

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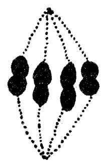

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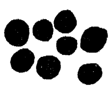

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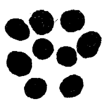

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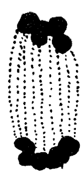

19

A. M. BORING.